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PUBLIC AND PRIVATE CAPITAL AND PUBLIC PRIVATE PARTNERSHIPS SERIES CONSTRUCTION FOR MOZAMBIQUE, 1960 – 2017

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Abstract: This article is about the construction of time series on the stock of public and private capital and Public Private Partnerships (PPPs) in Mozambique, from 1960 to 2017, in local currency (meticais), at constant 2009 prices. The construction of these series was based on the IMF methodology, using data on investment and on the depreciation of the capital stock, based on a geometric depreciation model. For investment, data from the National Institute of Statistics (INE) gross fixed capital formation (GFCF), from 1991 to 2017, were considered. For the periods previous to 1991, INE investment data were extended regressively, from 1990 to 1960, considering the proportions of investment in real GDP, by sectors: public, private and PPPs. For this purpose, the proportions of total investment implicit in the IMF data from 1960 to 2013 were used. These proportions were applied to INE GDP data) to obtain the investment data in metical's at 2009 constant prices, from 1960 to 1990. The result of the capital stock series shows an increasing trend of the total capital stock from 1960 to 2017. From the beginning of the 90's until roughly 2014, the public capital stock exceeded the stock of private capital. The share of the public capital stock in the total capital stock is, in general, greater than the share of the private capital stock. These data shows that despite Mozambique embarked on capitalism, the private sector development remained weak, with a low investment capacity in fixed capital to increase its capital stock.

JEL codes:

Index terms: *capital stock, public capital stock, private capital stock, public private partnership capital stock, investments, GDP, capital stock depreciation.*

I. INTRODUCTION

Mainstream economic theories emphasise that global production of the economy has capital as one of the main factors of production, along with the labour force. Hence, capital is relevant for specifying production functions. The product generated in the economy results from the combination of factors such as capital and labour, which makes the analysis of the capital stock relevant in understanding product dynamics.

This article presents results from the construction of time series on the stock of public, private, and Public Private Partnerships (PPPs) capital for Mozambique, from 1960 to 2017, in meticais, at constant 2009 prices.

In Mozambique, the INE is the entity responsible for the production and dissemination of statistics, but, despite publishing a wide variety of economic and social statistical data, does not provide data on the capital stock. This article considered previously published data on public, private and PPP capital stock from 1991 to 2013 made available by the International Monetary Fund (IMF), in 2005 purchasing power parity dollars, as a comparative basis[1].

The series construction of capital stock in meticais (local currency) is relevant for the specific Mozambican economy studies, contrary to the series on the IMF capital stock that are in purchasing power parity (in 2005 dollars), relevant for comparative studies across countries.

The construction of the capital stock series require series on investment (aggregate and by public, private

[1] Investment and capital stock (ICSD), http://data.imf.org

and PPP sectors); the rate of depreciation of the capital stock; as well as data on real GDP, at constant prices for 2009, as explained in the methodology.

The capital stock can be tangible or intangible (Nehru and Dhareshwar, 1993). Only tangible fixed capital stock is analysed here, as it is still predominant in developing economies and, therefore, on which the generation of domestic product depends even more, despite the indispensable relevance of the intangible capital stock itself.

Capital stock increases as a result of new asset acquisitions via fixed capital investment. On the other hand, as assets are discontinued, the capital stock reduces, depending on its useful age. New investments, sufficiently large, are expected to continually increase the capital stock. (Ball, *et. al*, 1993)

The capital stock is relevant to assess structural transformations of the economy over time. The GDP growth rates and capital returns are decisive for the capital stock progress. The accumulation of the capital stock also induces labour productivity and GDP growth. (Bergheim, 2008)

As Berlemann and Wesselhoft (2014) emphasise, a country's capital stock is not directly observable. Its estimation requires appropriate techniques and reliable data.

From capital stock it is possible to calculate the "capital services", necessary for the determination of changes in the economy's productivity, potential output, capital/output ratio, rates of return on capital, as well as for estimating investment demand and for identifying factors determining economic growth. (Holz e Yue, 2017)

Rudolf and Zurlinden (2008) indicate the estimates of net capital stock and aggregate capital services of Switzerland, using the Permanent Inventory Method, from 1970 to 2005. Da Silva and Lains (2013) calculated the Portugal's capital stock from 1910 to 2011, establishing the relationship between capital formation and the long-term growth of the Portuguese economy. They concluded that periods of Portugal greater economic growth were associated with periods of capital stock growth. However, they found that the accumulation of the capital stock, itself, did not result in greater economic growth, because it depends on a combination of other factors.

As mentioned by these authors, capital can be defined as gross capital stock, net capital stock and/or capital services. The gross capital stock is the capital stock without deducting the consumption of capital i.e. depreciation. Excluding depreciation, we obtain the stock of net capital. Therefore, the gross capital stock at a given moment corresponds to the value of capital goods existing at each price, without incorporating the value of their depreciation.

Oulton and Wallis (2016) presented annual fixed capital stock estimates for the UK, from 1950 to 2013, covering eight types of assets (infrastructure, machinery, vehicles, computers, purchased software, generated software, mineral exploration and original arts) and estimate the capital services generated by the existing capital stock, using endogenous (ex-ante) and ex-post rates of return.

Berlemann and Wesselhoft (2014) built new estimates of the aggregate capital stock for a set of 103 countries, applying the Permanent Inventory Method (MIP), starting from investment data, obtained from the World Bank's World Development Indicators database.

Erumban and Das (2014) consider that in the MIP the capital stock is taken as the weighted sum of all past investments, where the weights are based on relative efficiency, which decreases as capital ages over time. In this case, the level of efficiency can also vary according to the type of asset that makes up the capital stock.

According to Inklaar (2010), the lifetime of each asset depends on the nature of the asset, and it is, therefore, during the lifetime of the asset that it provides work, that is, the service of capital. For example, it states that the lifetime of buildings comprises decades, while that of machinery has a productive life cycle ranging from 10 to 20 years, while that of software is 3 to 5 years, which means that they become obsolete more quickly compared to other assets. Hence, the study of the relationship between output and the productive capacity of the economy, determining the additional output over time, involves an analysis of the dynamics of the capital stock. The analysis of the overall production of the economy and the accumulation of the productive capacity generated requires a careful analysis of capital stock dynamics. Analysis of the contribution of capital to economic growth, as well as other macroeconomic analysis, requires consistent data on the capital stock, hence the relevance of constructing time series on the capital stock.

This article is organized as follows: it starts with this introduction, followed by the methodology adopted in the construction of the time series on GDP, total investment, public, private and PPPs, and the series of total public, private and PPPs capital stock. The third part presents the constructed series and the fourth part analyses the results obtained, ending with the conclusion.

II. METHODOLOGY

For the construction of the capital stock series, the IMF methodology was followed, based on investment and capital stock depreciation data. (IMF, 2015) This work assumes a geometric depreciation model, which means

that capital efficiency declines at a constant rate over time. (Rudolf and Zurlinden, 2008)

2.1. Investment Data

For investment, gross fixed capital formation (GFCF) data from 1991 to 2017 were considered[2]. The data required cover the period from 1960 to 2017. For this, it was necessary to extend backwards the data on INE's investment, from 1990 to 1960. For this purpose, the proportions of investment in real GDP, by sectors (public, private and PPPs) of the IMF data for Mozambique, were used. Therefore, the composition of the total investment implicit in the IMF data, from 1960 to 2013 was recovered. These proportions allowed, from the INE GDP data, to obtain the investment data in meticals at constant prices for 2009, in the period of 1960 to 2013.

The calculation of public, private and PPP investment, from 2014 to 2017 followed another methodology. For this period, INE's total investment data (GFCF) from 2014 to 2017 were considered, and the growth rate of total investment was calculated. Based on the investment growth rates obtained, the part of the total investment, obtained from the sum of public, private and PPPs investments, from 1960 to 2013, was extended progressively from 2014 to 2017.

Having obtained the total investment data from 2014 to 2017, the composition of the total investment was followed, according to the IMF proportions (65.2% for private investment and 30% for public investment and 4.8% for PPPs), to obtain the shares of public, private investment and PPPs from 2014 to 2017, at current prices and in 2009 meticals.

This methodology enabled the global reconstruction of series on public, private, PPPs and total investment, in meticals at constant 2009 prices, from 1960 to 2017, necessary for the subsequent calculation of the capital stock.

2.2. About GDP

As mentioned above, data for real GDP in meticals at 2009 prices, from 1960 to 2017, were needed for the investment series, given that the available data on real GDP in meticals at 2009 constant prices, published by INE, cover the period from 1991 to 2017. Data on real GDP in meticals at 2009 prices, from 1960 to 1990, were obtained regressively. For this purpose, data on real GDP in 2011 dollars from the Penn World Table (PWT), version 9.1, from 1960 to 2017, and the INE real GDP database were used.

The real GDP growth rates of the two series were calculated (real GDP in meticals, from 1991 to 2017 and real GDP in dollars by PWT, from 1960 to 2017). The result showed that there is consistency and equality between the growth rates in the two series. The growth rates obtained from the PWT real GDP data were applied to the INE real GDP data series, regressively, reconstructing the real GDP data, in meticals at 2009 constant prices, from 1960 to 1990.

Once the real GDP data were obtained, in meticals 2009 prices, from 1960 to 2017, data on public, private and PPP investment were computed. Data on PPPs are available from 1997 onwards.

2.3. About the capital stock

The construction of series for capital stock was based on the investment and depreciation rate series.

For the construction of series on the capital stock, it is crucial to obtain the value of the initial capital stock for the period under analysis, requiring data on investment, the rate of depreciation of the capital stock and the growth rate of investment in the period.

The series on investment in meticals, at 2009 prices, from 1960 to 2017, disaggregated into public, private and PPP investment, served as the basis for calculating the stock of public, private and PPP capital.

The depreciation rates defined by IMF (2015) were considered, 2.5% for the public capital stock and 4.25% for the private capital stock. The same depreciation rate applied to the public capital stock was considered for the PPP capital stock.

To determine the initial capital stock, the calculation model presented by Inklaar & Timmer (2013) and by Berlemann & Wesselhoft (2014) was applied, as follows:

$$K_o = \frac{I_0}{g+\delta} \quad (1)$$

Were:

K_o - Represents the initial capital stock;

I_0 - Denotes the initial investment;

g - Illustrates the investment growth rate in the period under study; and

δ - Represents the depreciation rate

Where 1960 was considered as the initial year. The calculation of the initial PPPs capital stock followed a different methodology. Since the registration of PPPs

[2] Instituto Nacional de Estatística de Moçambique (INE), http://www.ine.gov.mz/estatisticas/estatisticas-sectoriais/@@search?SearchableText=PIB%2A&path=/Plone, acessed on 24-07-2019.

investment starts in 1997, for the beginning of that year, the capital stock was considered as null. From that year on, the Permanent Inventory Method (MIP) was applied.

The MIP starts from the central idea that the capital stock of an economy is an inventory, whereby the inventory stock increases with the formation of fixed capital, that is, with capital investments, increasing the existing capital stock (Berlemann e Wesselhoft, 2014), hence the relevance of investment data for calculating the capital stock.

Calculating the initial capital stock, the capital stock of subsequent years was calculated, from 1961 to 2017 for the public and private sector, and from 1998 to 2017 for PPPs.

The capital stock calculated is related to the capital stock at the beginning of each year, based on the IMF (2015) MIP, expressed in equation (2):

$$K_{t+1} = (1-\delta)K_t + \left(1-\frac{\delta}{2}\right)I_t \quad (2)$$

Were:

K_t - Indicates the capital stock at the beginning of the year t;

I_t – The investment (or GFCF) in period t; assuming that new investments are operationalized in the middle of the period;

δ - Represents the rate of depreciation of the capital stock.

Applying equation (2), the series of public and private capital stock, from 1960 to 2017 and the PPP capital stock, from 1997 to 2017, in meticals, at 2009 constant prices, were generated.

III. SERIES OBTAINED

According to the methodology described above, data series on the stock of public, private, PPPs and total capital (the sum of the three) were generated from 1960 to 2017. Since there were no necessary data in meticals at 2009 constant prices (as a reference for INE data), covering the period under study, it was necessary to build in advance other series, for real GDP and for investment.

a) Real GDP and investment

Series were constructed with data on real GDP and Investment, in meticals and at 2009 constant prices, in the period from 1960 to 2017. These results are shown in table 1.

Table 1 – Real GDP and Investment (public, private, PPPs and total)

Year	GDP at 2009 constant prices (10^6 MTN)	Public Investiment at 2009 constant prices (10^6 MTN)	Private Investiment at 2009 constant prices (10^6 MTN)	PPP Investiment at 2009 constant prices (10^6 MTN)	Total Investment at 2009 constant prices (10^6 MTN)
1960	35838	1717	2186	0	3903
1961	36468	1783	2272	0	4055
1962	39560	1855	2366	0	4221
1963	40370	1930	2459	0	4388
1964	42028	2009	2555	0	4564
1965	42645	2090	2661	0	4751
1966	43213	2169	2766	0	4935
1967	48144	2258	2874	0	5132
1968	50317	2350	2994	0	5344
1969	53813	2443	3110	0	5554
1970	51861	2541	3236	0	5777
1971	55742	2731	3478	0	6210
1972	58463	2865	3648	0	6513
1973	61159	2997	3816	0	6813
1974	64988	3184	4055	0	7240
1975	66341	3244	4133	0	7377
1976	70068	3433	4372	0	7806
1977	69942	3427	4364	0	7792
1978	70693	3450	4397	0	7847
1979	72867	3585	4569	0	8154
1980	75948	3721	4739	0	8461
1981	76921	3715	4738	0	8454
1982	74000	3722	4736	0	8458
1983	64263	1735	2211	0	3946
1984	66211	364	4708	0	5072
1985	60369	2493	1455	0	3948
1986	61342	3306	2895	0	6202
1987	64263	3644	3682	0	7326
1988	67185	3682	4253	0	7934
1989	71552	3649	4751	0	8400
1990	72267	2761	6612	0	9373
1991	75808	8491	485	0	8976
1992	71842	7479	876	0	8355
1993	78141	7564	1125	0	8689
1994	82953	10178	821	0	11000
1995	84809	8023	4020	0	12043
1996	107577	8929	4949	0	13877
1997	119240	11125	4972	1753	17850
1998	133381	10097	5895	1747	17740
1999	143816	12512	6083	1942	20537
2000	146230	11274	17825	2091	31191
2001	164832	18675	3428	2423	24527
2002	179327	12983	16444	646	30073
2003	190984	15202	11937	7448	34587
2004	205902	14516	11098	7639	33253
2005	223858	13611	14685	7656	35952
2006	245911	21984	8386	7746	38116
2007	264172	25545	6631	7740	39916
2008	282337	27951	9938	1694	39584
2009	300270	35312	4654	1351	41317
2010	320351	30145	10379	1922	42447
2011	343153	21859	32462	4289	58610
2012	367853	17914	58930	2501	79346
2013	394124	19943	50803	2917	73662
2014	423463	27400	60280	4384	91333
2015	451386	16931	50088	3386	70546
2016	468372	11776	47106	2975	61982
2017	485875	11998	55051	3388	70578

In the case of PPPs data are available from 1997 onwards, this is due to the fact that historically PPPs only started in the late 90s of the 20th century. The economy of independent Mozambique began as a centralized economy, after the III FRELIMO Congress in 1977. The beginning of the liberalization of the economy, materialized after the privatization process, with the implementation of the Economic Rehabilitation Program (PRE), initiated in 1987, paved the way for the development of a private business sector, later enabling the emergence of PPPs.

b) *Capital stock*

The results of the construction of the public, private, PPPs and total capital stock series are shown in table 2 below:

Table 2 - Capital stock (public, private, PPP, and total)

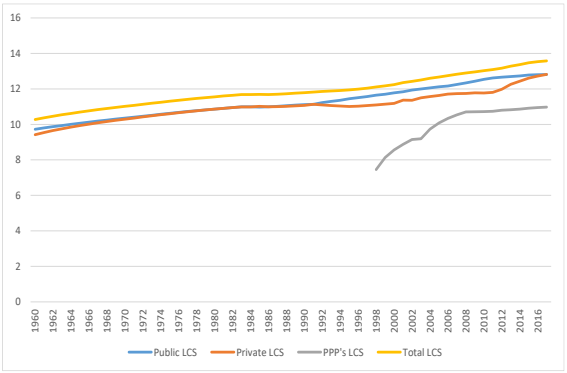
Year	Public Capital Stock at 2009 constant prices (10^6 MTN)	Private Capital Stock at 2009 constant prices (10^6 MTN)	PPP Capital Stock at 2009 constant prices (10^6 MTN)	Total Capital Stock at 2009 constant prices (10^6 MTN)
1960	16781	12344	0	29125
1961	18056	13959	0	32015
1962	19366	15590	0	34955
1963	20714	17242	0	37956
1964	22102	18916	0	41018
1965	23533	20613	0	44146
1966	25008	22341	0	47350
1967	26525	24099	0	50624
1968	28092	25888	0	53979
1969	29710	27718	0	57428
1970	31380	29584	0	60964
1971	33105	31494	0	64599
1972	34974	33560	0	68534
1973	36929	35704	0	72633
1974	38965	37922	0	76887
1975	41135	40279	0	81415
1976	43310	42613	0	85923
1977	45618	45081	0	90699
1978	47862	47437	0	95299
1979	50072	49724	0	99797
1980	52361	52083	0	104443
1981	54726	54508	0	109234
1982	57027	56829	0	113856
1983	59277	59049	0	118326
1984	59509	58703	0	118212
1985	58381	60816	0	119196
1986	59383	59655	0	119038
1987	61164	59954	0	121117
1988	63233	61010	0	124242
1989	65288	62579	0	127867
1990	67259	64569	0	131828
1991	68303	68297	0	136601
1992	74980	65869	0	140850
1993	80491	63928	0	144419
1994	85948	62312	0	148261
1995	93851	60468	0	154319
1996	99427	61832	0	161260
1997	105759	64048	0	169807
1998	114101	66193	1731	182024
1999	121219	69150	3413	193782
2000	130544	72165	5245	207954
2001	138414	86544	7179	232137
2002	153396	86222	9392	249010
2003	162382	98652	9795	270829
2004	173334	106142	16905	296382
2005	183336	112494	24026	319856
2006	192193	122086	30986	345264
2007	209098	125105	37860	372063
2008	229096	126277	44557	399931
2009	250971	130638	45116	426725
2010	279567	129641	45323	454531
2011	302346	134290	46088	482724
2012	316373	160355	49171	525899
2013	326154	211218	50412	587784
2014	337694	251964	52032	641690
2015	356309	300255	55060	711624
2016	364121	336517	57028	757665
2017	366647	368320	58540	793507

IV. ANALYSIS

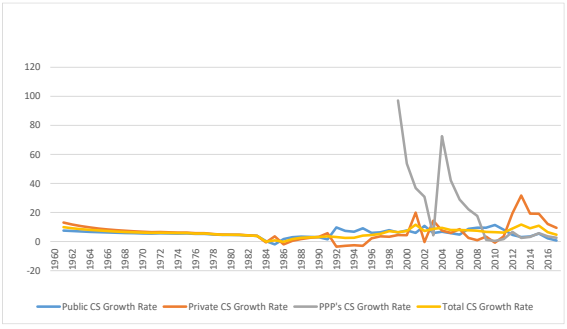
a) The dynamics of the capital stock

From the series on the capital stock, the behaviour of the capital stock in the period under study is analysed, as illustrated in the figures below.

Graphic 1 - Stock of public, private, PPPs and total capital, logarithmized, 1960-2017



Graphic 2 - Growth rates Public, private, PPP and total capital stock, 1960-2017



The graphic illustrates that the growth rate of the stock of public, private and total capital decreased in the period between 1960 and 1984.

In 1985 there was a fall in the stock of public capital growth rate. This fall is associated with the peak of the economic crisis that forced the introduction of PRE in 1986, for economic recovery, taking it from a centrally planned economy to a market model.

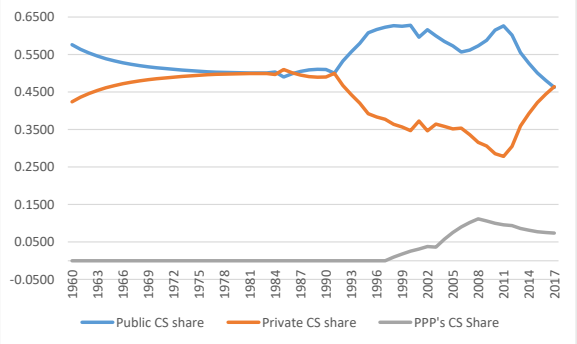
From 1992 to 1995 the growth rate of the private capital stock dropped significantly in 1992 and remained unchanged until 1995. This may be associated with the uncertainties generated after the

end of the war and the holding of the first multi-party general elections that culminated in the constitution of the first democratically elected government in the country. However, in the same period there was an increase in the stock of public capital, which may be associated with the effort to restore infrastructure in the post-war period, with the end of the war in 1992.
In 2001, the remarkable growth of the private capital stock may be associated to the recovery effort that took place after the impact of the 2000 floods.
The period from 2006 to 2011 illustrates a scenario similar to that from 1992 to 1995, with a growth rate of the public capital stock higher than that of the private capital stock. In 2011 there was an inversion with a higher growth rate of the private capital stock, reaching its maximum value in 2013. As of 2014, the stock of public, private and PPPs capital shows a decreasing trend.
In relation to the stock of public capital, decrease starts in 2011.
The growth rate of the PPPs capital stock was significant in 1999 and 2004, coincidentally associated to the electoral periods in the country.
The growth rate of the total capital stock has kept a decreasing trend until 1986, having registered an increasing trend from 1987 to 2013.
In global terms, the total capital stock indicates an increasing trend from 1960 to 2017. However, between 1983 and 1986 it went through a period of stabilization in the growth trend. This period coincides with the greatest economic crisis in the country, after the severe droughts of 1982 and 1983, associated with the greatest intensification of the civil war. Significant growth resumed after 1992, when the country reached peace, recovering the growth trend of the periods prior to 1982/83.
In relation to the stock of public and private capital, it appears that from 1960 to 1969 the stock of public capital was higher than the stock of private capital. The same was more significantly true from 1991 to 2016.
These data illustrate that despite Mozambique having embarked on a market economy, the development of the private sector remained weak, indicating a private sector with little capacity to invest in fixed capital and to increase its capital stock.
From 2016 onwards, the data indicate an approximation between the stock of public and private capital, which from 2011 onwards experienced accelerated growth.
In relation to the capital stock of PPPs, it grew significantly from 1998 to 2008, when its growth stabilized until 2011, restarting a period of recovery of its growth.

b) The composition of the total capital stock

The point analyses the participation of the public, private and PPP capital stock in the total capital stock, showing the trend of this participation over time.

Graphic 3 - Participation in total capital stock

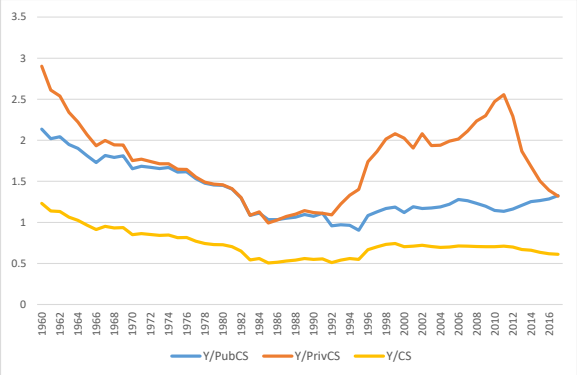


In global terms, the data indicate that the public capital stock has had a greater participation in the total capital stock, compared to the private capital stock.
From 1960 to 1978, the share of the public capital stock in the total capital stock had a decreasing trend, while the share of the private capital stock increased.
From 1979 to 1983, there was a stabilization and equality in the participation of the two types of capital stock, in the total capital stock. It was in 1985 that the private capital stock surpassed the public capital stock, which may have been not because of the growth of the private capital stock but because of the reduction of the public capital stock, as a reflex of the war and the direct destabilization of the then regime of the apartheid of South Africa. It was due to the gravity of this situation that in 1984 a good neighbour agreement was signed between the two countries, which became known as the Nkomati Agreement to alleviate the destabilizing pressure in South Africa.
From 1992 to 2011 there is a greater participation of the public capital stock in the total capital stock, but after 2011 there is an approximation in the participation rates of public and private capital stock.
The participation of the PPPs capital stock increased from 1998 to 2008 but from 2009 onwards this participation decreased.

c) GDP to capital ratio (Capital productivity)

The product to capital ratio is a measure of the productivity of capital.

Graphic 4 - Product to capital stock ratio, 1960-2017

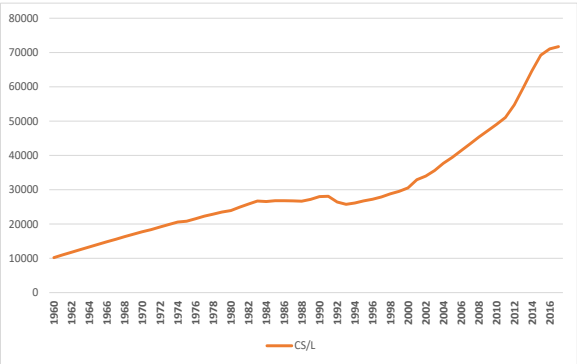


In global terms, the productivity of capital had a decreasing trend from 1960 to 1987. During this period, it recorded some recovery between 1967 and 1969. From 1993 onwards there has been a slight improvement in the productivity of capital. However, as of 2013 this trend is reversed.

d) Capital to employment ratio

This ratio measures the stock of capital available per worker. According to Berlemann and Wesselhoft (2014), the capital per worker ratio indicates the intensity of capital, so the greater the intensity of capital, the greater the amount of capital stock available per worker in the production process, leading to a greater production.
For this analysis, employment data from Federal Reserve Economic Data (FRED) was used, from 1960. (Feenstra, *et al.*, 2015)

Graphic 5 - Capital stock to employment ratio



The result indicates that the stock of capital available per employment shows an increasing trend over time, despite the slight reduction between 1991 and 1993. The growth trend is accelerated from 1994, the period after the end of the war in Mozambique. However, it slows down in 2015, a period in which the country entered a complex economic crisis.

CONCLUSION

The article aimed to present the result of the construction of stock of public and private capital time series and Public Private Partnerships (PPPs) in Mozambique, from 1960 to 2017, in local currency (meticals) and at 2009 constant prices. The absence of these data in a systematic way for the Mozambican economy and in local currency made it necessary to mobilize different methodologies to allow recovering necessary data for the construction of the intended series.
Data recovery allowed building series on GDP, public, private and PPPs investments and, based on these data, building series on the stock of public-private capital and PPPs.
Results show an increasing total capital stock trend from 1960 to 2017. From the beginning of the 90s until roughly 2014, public capital stock surpassed the private capital stock. On the other hand, the participation of the public capital stock in the total capital stock is also, in general, greater than the participation of the private capital stock. These data illustrate that despite Mozambique having embarked on a market economy, private sector development remained weak - the private sector displayed weak investment capacity to increase its capital stock.
One of the limitations of this study is associated with the absence of data on investment by assets and by activity sector. The analysis by assets would allow a better assessment of the dynamics of the investment composition, the investment pattern, as well as the nature of the dominant capital stock in the economy, for a better understanding of the patterns of structural changes that occur in the Mozambican economy.

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